WHAT IS CLAIMED IS:

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3   1.   In a data network, a method of accessing an object in a meta file system

4   stored in a network file server, the meta file system including a plurality of file system

5   cells, the method comprising:

6   a network client sending a directory lookup request for the object to the network

7   file server;

8   the network file server receiving the directory lookup request, and in response,

9   performing a directory lookup for the object, and returning to the network client a file

10   handle for the object, the file handle including an identifier of a file system cell including

11   the object, and a pointer to the object in the file system cell;

12   the network client receiving the file handle for the object, sending to the network

13   file server a request for access to the object, the request for access to the object including

14   the file handle for the object; and

15   the network file server receiving the request for access to the object, and in

16   response, the network file server extracting the file system cell identifier and the object

17   pointer from the file handle included in the request for access, using the file system cell

18   identifier to find the file system cell that includes the object, and using the object pointer

19   to find the object in the file system cell.

20

21   2.   The method as claimed in claim 1, wherein:

22   in response to the directory lookup request, the network file server also includes

23   in the file handle an indication that the object is not in online storage, and

1   in response to the request for access to the object, the network file server inspects

2   the file handle included in the request for access, and upon inspecting the file handle and

3   finding the indication that the object is not in online storage, the network file server

4   begins a process of moving the object from offline storage to online storage.

5

6   3.   The method as claimed in claim 1, wherein the network client and the

7   network file server use the Network File System (NFS) protocol when communicating

8   the directory lookup request and the request for access to the object.

9

10   4.   The method as claimed in claim 1, wherein the network client and the

11   network file server use the Common Internet File System (CIFS) protocol when

12   communicating the directory lookup request and the request for access to the object.

13

14   5.   The method as claimed in claim 1, wherein the file system cells are file

15   system cells of a Unix-based file system, and the network file server accesses the Unix-

16   based file system to obtain the pointer to the object in the file system cell, and the pointer

17   to the object in the file system cell is a Unix-based file identifier.

18

19   6.   The method as claimed in claim 1, wherein the network file server

20   includes a plurality of processors, and each of the file system cells has a respective one of

21   the processors that is assigned exclusive management of metadata of said each of the file

22   system cells, and wherein the network file server responds to the file access request by

23   accessing a routing table with the extracted identifier of the file system cell in order to

1   obtain a pointer to the respective one of the processors that is assigned exclusive

2   management of metadata of the file system cell including the object, and using the

3   pointer to the respective one of the processors to send a request to the respective one of

4   the processors for management of metadata of the file system cell for accessing the

5   object.

6

7   7.   The method as claimed in claim 6, which includes the network file server

8   finding a reference to another one of the file system cells during the accessing of the

9   object after using the pointer to the respective one of the processors, and accessing the

10   routing table to find a pointer to the respective one of the processors that is assigned

11   exclusive management of metadata of said another one of the file system cells, and using

12   the pointer to the respective one of the processors that is assigned exclusive management

13   of metadata of said another one of the file system cells to send a request to the respective

14   one of the processor that is assigned exclusive management of metadata of said another

15   one of the file system cells for access to metadata of said another one of the file system

16   cells.

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18   8.   The method as claimed in claim 6, wherein the routing table includes a

19   plurality of entries, and each entry includes a respective file system identifier of a file

20   system cell in the meta file system, and an associated pointer to the respective one of the

21   processors assigned exclusive management of the metadata of the file system cell

22   identified by said respective file system identifier of a file system cell in the meta file

23   system, and the method includes the network file server accessing the entry of the routing

1 table containing the file system identifier of the file system cell including the object in

2 order to obtain the associated pointer to the respective one of the processors assigned

3 exclusive management of the metadata of the file system cell including the object.

4

5   9.   The method as claimed in claim 6, wherein the routing table includes a

6 plurality of entries, and each entry includes a respective file system identifier of a file

7 system cell in the meta file system, and an associated pointer to a file system cell object

8 containing a pointer to the respective one of the processors assigned exclusive

9 management of the metadata of the file system cell identified by said respective file

10 system identifier of a file system cell in the meta file system, and the method includes the

11 network file server accessing the entry of the routing table containing the file system

12 identifier of the file system cell including the object in order to obtain the associated

13 pointer to the respective file system cell object containing the pointer to the respective

14 one of the processors assigned exclusive management of the metadata of the file system

15 cell including the object.

16

17   10.   A method of accessing an object in a meta file system stored in a network

18 file server, the network file server including a cached disk array and a plurality of data

19 mover computers for moving data between the cached disk array and a data network, the

20 meta file system including a plurality of file system cells, each of the file system cells

21 having a respective one of the data mover computers assigned exclusive management of

22 metadata of said each of the file system cells, said method comprising:

23   storing a routing table in each of the plurality of data mover computers, each of

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1   the plurality of routing tables including an entry for each file system cell, each entry

2   including a respective file system cell identifier and associating the respective file system

3   cell identifier with a pointer to the respective one of the data mover computers assigned

4   exclusive management of metadata of the file system cell identified by said respective

5   file system cell identifier;

6   in response to the network file server receiving a request from the network for a

7   file handle for a file, the network file server producing a file handle for the file, the file

8   handle containing a file identifier obtained from the file system cell and a file system

9   identifier for the file system cell containing the file; and

10   at least one of the data mover computers receiving a subsequent request from the

11   network for access to the file, the request for access to the file including the file handle,

12   said at least one of the data movers responding to the request for access to the file by

13   accessing the routing table to obtain the pointer to the respective one of the data movers

14   assigned exclusive management of metadata of the file system cell containing the file in

15   order to obtain management of metadata of the file system cell containing the file in order

16   to access to the file.

17

18   11.   The method as claimed in claim 10, wherein the step of producing the file

19   handle includes interpreting a meta file system path specification associated with the file.

20

21   12.   The method as claimed in claim 10, wherein each entry of the routing

22   table includes a respective pointer to a respective file system cell object containing

23   information associated with the file system cell identified by said respective file system

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1   cell identifier in said each entry, the information associated with the file system cell

2   including a pointer to the data mover assigned exclusive management of metadata of the

3   file system identified by said respective file system cell identifier in said each entry.

4

5   13.   The method as claimed in claim 12, wherein the respective file system cell

6   object includes a local/remote flag indicating whether or not said at least one of the data

7   mover computers is assigned exclusive management of metadata of the file system

8   identified by said respective file system cell identifier in said each entry.

9

10   14.   The method as claimed in claim 12, wherein the respective file system cell

11   object includes a specification of a communication protocol to be used by said at least

12   one of the data mover computers for communicating with the data mover assigned

13   exclusive management of metadata of the file system identified by said respective file

14   system cell identifier in said each entry.

15

16   15.   The method as claimed in claim 10, wherein the request from the network

17   for a file handle and the subsequent request from the network for access to the file are

18   communicated over the network using the Network File System (NFS) protocol.

19

20   16.   The method as claimed in claim 10, wherein the request from the network

21   for a file handle and the subsequent request from the network for access to the file are

22   communicated over the network using the Common Internet File System (CIFS) protocol.

23

1   17.   A network file server comprising data storage for storing a meta file

2   system, the meta file system including a plurality of file system cells, and the network file

3   server having at least one network port coupled to the data storage for providing network

4   clients with access to the meta file system in the data storage, wherein the network file

5   server is programmed for:

6   receiving, from a network client, a directory lookup request for an object in the

7   meta file system, and in response, performing a directory lookup for the object, and

8   returning to the network client a file handle for the object, the file handle including an

9   identifier of a file system cell including the object, and a pointer to the object in the file

10   system cell; and

11   receiving, from the network client, a request for access to the object, the request

12   for access to the object including the file handle for the object, and in response to receipt

13   of the request for access to the object, extracting the file system cell identifier and the

14   object pointer from the file handle included in the request for access, using the file system

15   cell identifier to find the file system cell that includes the object, and using the object

16   pointer to find the object in the file system cell.

17

18   18.   The network file server as claimed in claim 17, wherein the network file

19   server is also programmed to respond to the directory lookup request by also including in

20   the file handle an indication that the object is not in online storage, and

21   the network file server is also programmed to respond to the request for access to

22   the object by inspecting the file handle included in the request for access, and upon

23   inspecting the file handle and finding the indication that the object is not in online

1   storage, beginning a process of moving the object from offline storage to online storage.

2

3   19.   The network file server as claimed in claim 17, wherein the network file

4   server is programmed for using the Network File System (NFS) protocol when sending

5   the directory lookup request and when receiving the request for access to the object.

6

7   20.   The network file server as claimed in claim 17, wherein the network file

8   server is programmed for using the Common Internet File System (CIFS) protocol when

9   sending the directory lookup request and when receiving the request for access to the

10   object.

11

12   21.   The network file server as claimed in claim 17, wherein the file system

13   cells are file system cells of a Unix-based file system, and the network file server is

14   programmed for accessing the Unix-based file system to obtain the pointer to the object

15   in the file system cell, and the pointer to the object in the file system cell is a Unix-based

16   file identifier.

17

18   22.   The network file server as claimed in claim 17, wherein the network file

19   server includes a plurality of processors, and each of the file system cells has a respective

20   one of the processors that is assigned exclusive management of metadata of said each of

21   the file system cells, and wherein the network file server is programmed for responding

22   to the file access request by accessing a routing table with the extracted identifier of the

23   file system cell in order to obtain a pointer to the respective one of the processors that is

1   assigned exclusive management of metadata of the file system cell including the object,

2   and using the pointer to the respective one of the processors to send a request to the

3   respective one of the processors for management of metadata of the file system cell for

4   accessing the object.

5

6   23.   The network file server as claimed in claim 22, wherein the network file

7   server is programmed for finding a reference to another one of the file system cells

8   during the accessing of the object after using the pointer to the respective one of the

9   processors, and accessing the routing table to find a pointer to the respective one of the

10   processors that is assigned exclusive management of metadata of said another one of the

11   file system cells, and using the pointer to the respective one of the processors that is

12   assigned exclusive management of metadata of said another one of the file system cells to

13   send a request to the respective one of the processor that is assigned exclusive

14   management of metadata of said another one of the file system cells for access to

15   metadata of said another one of the file system cells.

16

17   24.   The network file server as claimed in claim 22, wherein the routing table

18   includes a plurality of entries, and each entry includes a respective file system identifier

19   of a file system cell in the meta file system, and an associated pointer to the respective

20   one of the processors assigned exclusive management of the metadata of the file system

21   cell identified by said respective file system identifier of a file system cell in the meta file

22   system.

23

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1   25.   The network file server as claimed in claim 22, wherein the routing table

2   includes a plurality of entries, and each entry includes a respective file system identifier

3   of a file system cell in the meta file system, and an associated pointer to a file system cell

4   object containing a pointer to the respective one of the processors assigned exclusive

5   management of the metadata of the file system cell identified by said respective file

6   system identifier of a file system cell in the meta file system.

7

8   26.   A network file server including a cached disk array and a plurality of data

9   mover computers for moving data between a data network and a meta file system stored

10   in the cached disk array, the meta file system including a plurality of file system cells,

11   each of the file system cells having a respective one of the data mover computers

12   assigned exclusive management of metadata of said each of the file system cells;

13   said network file server being programmed for storing a routing table in each of

14   the data mover computers, the routing table in each of the data mover computers

15   including an entry for each file system cell, each entry including a respective file system

16   cell identifier and associating the respective file system cell identifier with a pointer to

17   the respective one of the data mover computers assigned exclusive management of

18   metadata of the file system cell identified by said respective file system cell identifier;

19   said network file server being programmed for responding to receipt of a request

20   from the network for a file handle for a file by producing a file handle for the file, the file

21   handle containing a file identifier obtained from the file system cell and a file system

22   identifier for the file system cell containing the file; and

23   at least one of the data mover computers being programmed for receiving a

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1   subsequent request from the network for access to the file, the request for access to the

2   file including the file handle, said at least one of the data movers being further

3   programmed for responding to the request for access to the file by accessing the routing

4   table in said at least one of the data mover computers to obtain the pointer to the

5   respective one of the data movers assigned exclusive management of metadata of the file

6   system cell containing the file in order to obtain management of metadata of the file

7   system cell containing the file in order to access to the file.

8

9   27.   The network file server as claimed in claim 26, wherein the network file

10   server is programmed for interpreting a meta file system path specification associated

11   with the file in order to produce the file handle for the file.

12

13   28.   The network file server as claimed in claim 26, wherein each entry of the

14   routing table in said at least one of the data mover computers includes a respective

15   pointer to a respective file system cell object containing information associated with the

16   file system cell identified by said respective file system cell identifier in said each entry,

17   the information associated with the file system cell including a pointer to the data mover

18   assigned exclusive management of metadata of the file system identified by said

19   respective file system cell identifier in said each entry.

20

21   29.   The network file server as claimed in claim 28, wherein the respective file

22   system cell object includes a local/remote flag indicating whether or not said at least one

23   of the data mover computers is assigned exclusive management of metadata of the file

system identified by said respective file system cell identifier in said each entry.

30.   The network file server as claimed in claim 28, wherein the respective file system cell object includes a specification of a communication protocol to be used by said at least one of the data mover computers for communicating with the data mover assigned exclusive management of metadata of the file system identified by said respective file system cell identifier in said each entry.

31.   The network file server as claimed in claim 26, wherein the network file server is programmed for using the Network File System (NFS) protocol for communicating the request from the network for a file handle and the subsequent request from the network for access to the file.

32.   The network file server as claimed in claim 26, wherein the network file server is programmed for using the Common Internet File System (CIFS) protocol for communicating the request from the network for a file handle and the subsequent request from the network for access to the file.

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